NAVAL SUBMARINE MEDICAL RESEARCH LABORATORY

SUBMARINE BASE, GROTON, CONN.

REPORT NUMBER 934

INTERHEMISPHERIC ASYMMETRIES IN VISUAL EVOKED POTENTIAL AMPLITUDE

by

Christine L. Schlichting, David F. Neri

and

Scott W. Kindness

Naval Medical Research and Development Command
Research Work Unit MR041.01.03-0155

Released by:

R. A. Margulies, CDR, MC, USN
Commanding Officer
Naval Submarine Medical Research Laboratory

12 June 1980

INTERHEMISPHERIC ASYMMETRIES IN VISUAL EVOKED POTENTIAL AMPLITUDE

by

Christine L. Schlichting, Ph.D.
David F. Neri, B.A.
and
Scott W. Kindness, HM3, USN

NAVAL SUBMARINE MEDICAL RESEARCH LABORATORY
REPORT NUMBER 934

NAVAL MEDICAL RESEARCH AND DEVELOPMENT COMMAND
Research Work Unit MR041.01.03-0155

Approved and Released by

R. A. Margulies, CDR MC USN
Commanding Officer
NavSubMedRschLab

SUMMARY PAGE

PROBLEM

To determine which of several visual stimuli yields the greatest interhemispheric asymmetry in the visual evoked potential. Responses to these stimuli will be used as possible measures of performance capability in sonar operators.

FINDINGS

Four of the five stimuli used yielded approximately equal interhemispheric asymmetries at both the occipital and parietal locations. Subjects were generally consistent in the direction of asymmetry and showed greater amplitude in the right side of the brain.

APPLICATION

These results will be used in a future test of the relationship of the direction and magnitude of interhemispheric asymmetry to measures of performance in sonar operators.

ADMINISTRATIVE INFORMATION

This investigation was conducted as part of Naval Medical Research and Development Command Research Work Unit MR041.01.03-0155 - "Prediction of the performance of submarine watch standers by various indices of cortical functioning." It was submitted for review on 30 May 1980, approved for publication on 12 Jun 1980 and designated as NSMRL Report No. 934.

PUBLISHED BY THE NAVAL SUBMARINE MEDICAL RESEARCH LABORATORY

INTRODUCTION

The current views of the specialized functioning of the two sides of the brain have been developed using many experimental techniques. Behavioral tasks have included dichotic listening (Kimura, 1961, 1967), reaction time, and other tachistoscopic tests (Springer, 1977). Electrophysiological measures have also been widely used, with both the electroencephalogram and evoked potential being extensively employed in human studies (Begleiter, 1979; Callaway, 1975). Using both the behavioral and electrophysiological techniques investigators have looked not only at the general functioning of the brain but have extended these studies to include the functioning of specialized areas of the brain and the differences between the two sides of the brain (Marsh, 1978).

Results of these studies have suggested that in neurologically intact right-handed males the left hemisphere is primarily for language processing and the right hemisphere is primarily responsible for visuospatial processing.

A further suggestion in many of these studies is that the degree of hemispheric differentiation may be related to performance. It is this latter topic that is of particular interest to the Navy, since an objective predictor of performance capability would be extremely useful.

In an attempt to better define the nature of these differences and their relation to performance, a number of recent studies have concentrated on the evoked potential as a means to investigate lateralization of brain function. Measures of evoked potential variability, amplitude, and latency have all been utilized.

In adults, high evoked-potential variability has been found to be a characteristic of schizophrenics (Callaway, Jones and Layne, 1965) and of patients with Korsakoff's syndrome (Malerstein and Callaway, 1969). In the schizophrenics, the high variability is related to poor and variable perceptual performance (Inderbitzen, Buchsbaum and Silverman, 1970). In normal adults increased variability is negatively correlated with verbal I.Q. and is further sensitive to task uncertainty and interstimulus intervals.

In normal subjects the amplitude of the evoked potential is greater when recorded over the right hemisphere than over the left. This is true for flashes of light (Lewis and Rimland, 1980) and for letter and visuospatial stimuli (Rugg and Beaumont, 1979). Evoked potential amplitude has also been studied as a function of reading ability, general intelligence, and performance.

In the studies with readers the results suggest that the amplitude of the evoked potential in the left parietal area of the brain is smaller in disabled readers than in normal readers (Conners, 1970; Preston, Guthrie and Childs, 1974; Sobotka and May, 1977). Lewis, Rimland and Callaway (1976) found that EP amplitude correlated with successful completion of a remedial reading program.

Another amplitude study has shown EP amplitude asymmetries between the two sides of the brain to be greater in bright children than in dull children (Rhodes, Dustman, and Beck, 1969). This same study reported that right hemisphere amplitude was greater than left hemisphere amplitude in the normal and high performance subject. Richlin, Weisinger, Weinstein, Giannini and Morgenstern (1971) found the reverse asymmetry in retarded persons.

Lewis, Rimland and Callaway (1979) studied various measures of the evoked potential and found amplitude asymmetry values to be of use in predicting successful "on job" performance in Navy recruits. Lewis and Rimland (1980) also studied evoked potential measures and their relation to the performance of Navy sonar trainees on a sonar simulator. They found a large asymmetry at the occipital areas which favored the right hemisphere in the good performers and the left in the poorer performers. The study used a flashed white light as the VEP stimulus.

These evoked potential studies suggest that the amplitude of the evoked response may prove to be a useful tool in investigating differences in brain function and its relation to performance.

This study was, therefore, designed to determine whether VEP asymmetries could be produced using several different patterned visual stimuli and whether the degree of asymmetry varied with the stimulus used. If these asymmetries can be replicated, then future studies will be designed to investigate the relationship of these asymmetries to performance.

METHOD

Subjects

The subjects were four civilian employees of the Naval Submarine Medical Research Laboratory and one enlisted corpsman stationed at the same laboratory. All were neurologically intact right-handed males with no known left-handed relatives. They ranged in age from 21 to 50 years.

The Stimuli

Each stimulus target was photographically reproduced and subtended 5° horizontally and 3.6° vertically when placed 35.7 inches from the subject's eyes. They were illuminated by a Grass PS-2 photostimulator set

at an intensity of 4; this produced an overall luminance of the targets during the stimulation between 5 and 6 cd/m^2. Each target was illuminated for ten microseconds. The interstimulus interval was randomly varied with a mean of 3 seconds.

The stimuli consisted of five different targets:

1. A 50% contrast neutral gray

2. Texture I, a texture pattern divided into four quadrants (Santoro and Fender, 1976) with a visually different texture in one of the quadrants.

3. Texture II, a pattern with no visibly different quadrant

4. A vertically striped pattern in which each stripe subtended 1 degree (.5 cpd) at the viewing distance

5. A vertically striped pattern in which each stripe subtended .1 degree (5 cpd) at the viewing distance.

EEG Recording

Grass gold electrodes were placed on scalp sites O_1, O_2, P_3 and P_4 and referred to C_z. Electrode impedance was maintained at a level below 5 K. The EEG was amplified by Grass P511 preamplifiers. The gain in each channel was 50,000. Filter settings were .1 cps for the low frequency and .1 KC for the high frequency.

EEG Analysis

The EEG was analyzed with a PDP 1140 computer using a software averaging program developed locally. The EEG on each channel was digitized by the AR11 A-D converter. Fifty epochs of 512 msec were averaged for each brain site in each brain hemisphere for each stimulus. For each of these combinations the microvolts root mean square (μVRMS) power was calculated. The μVRMS power is obtained by determining the mean voltage for the averaged evoked potential. The deviations from the mean for each point are then taken and squared. Finally, an average of these squared deviations is obtained. The square root of this value is the μVRMS and represents the standard deviation of the waveform.

Procedure

Each subject participated in three experimental sessions. Order of presentation of the stimuli was large stripe, small stripe, gray blank, Texture II and Texture I for the first and last session. The order of presentation was reversed for the second session, and the preamplifiers used for the brain sides were reversed for the third session.

RESULTS

Figure 1 shows the results of the μVRMS power analysis. It can be seen from this figure that for the gray, the small stripe, the large stripe, and Texture II there was more power in the right hemisphere than in the left. Across all five stimuli the mean μVRMS for the right hemisphere was 2.83 while the mean μVRMS for the left hemisphere was 2.65. This effect was small, however, and showed a probability equal to .29 on a five-way ANOVA ($F(1,4)=1.48$). Variables in the ANOVA were stimulus type, relication, brain site, and brain side.

Individual subjects were generally consistent in the direction of asymmetry; less than 1/6 of the total possible comparisons were reversals. One of the five subjects consistently showed more power in the left hemisphere for all of the stimuli. When this subject was removed from the analysis the mean μVRMS for the right hemisphere was 2.90 and for the left hemisphere was 2.63. When this subject was deleted from the ANOVA, the probability of the right hemisphere effect improved to $\underline{p}=.13$ ($F(1,3)=4.17$).

Figure 1 also shows that the parietal area had consistently less power than the occipital area. Across all conditions the mean μVRMS for the parietal area was 2.34 while the mean power for the occipital area was 3.14. This effect showed a probability equal to .01 in the overall ANOVA ($F,1,4)=17.79$).

There was no significant difference among the five stimuli or among the three replications. Additionally, none of the interactions among the factors reached statistical significance at the $\underline{p}=.05$ level. As might be expected, over one half the variability in the data was contributed by the subject factor.

DISCUSSION

In summary, there appear to be replicable interhemispheric asymmetries with greater power in the right hemisphere in both the occipital and parietal recordings. The degree of asymmetry or the overall amplitude does not seem to vary as a function of the stimulus for the stimuli used in this experiment.

The consistency of hemisphere asymmetries in amplitude found in this study supports previous research suggesting that one side of the brain is preferentially engaged in the early processing of visual stimuli (Rugg and Beaumont, 1979; Lewis and Rimland, 1980). In most subjects this is the right side of the brain. Furthermore, there seems to be little difference in the degree of asymmetry across four of the five stimulus types employed in this study. Only the Texture I pattern seemed to yield equal amplitude responses from the two sides of the brain.

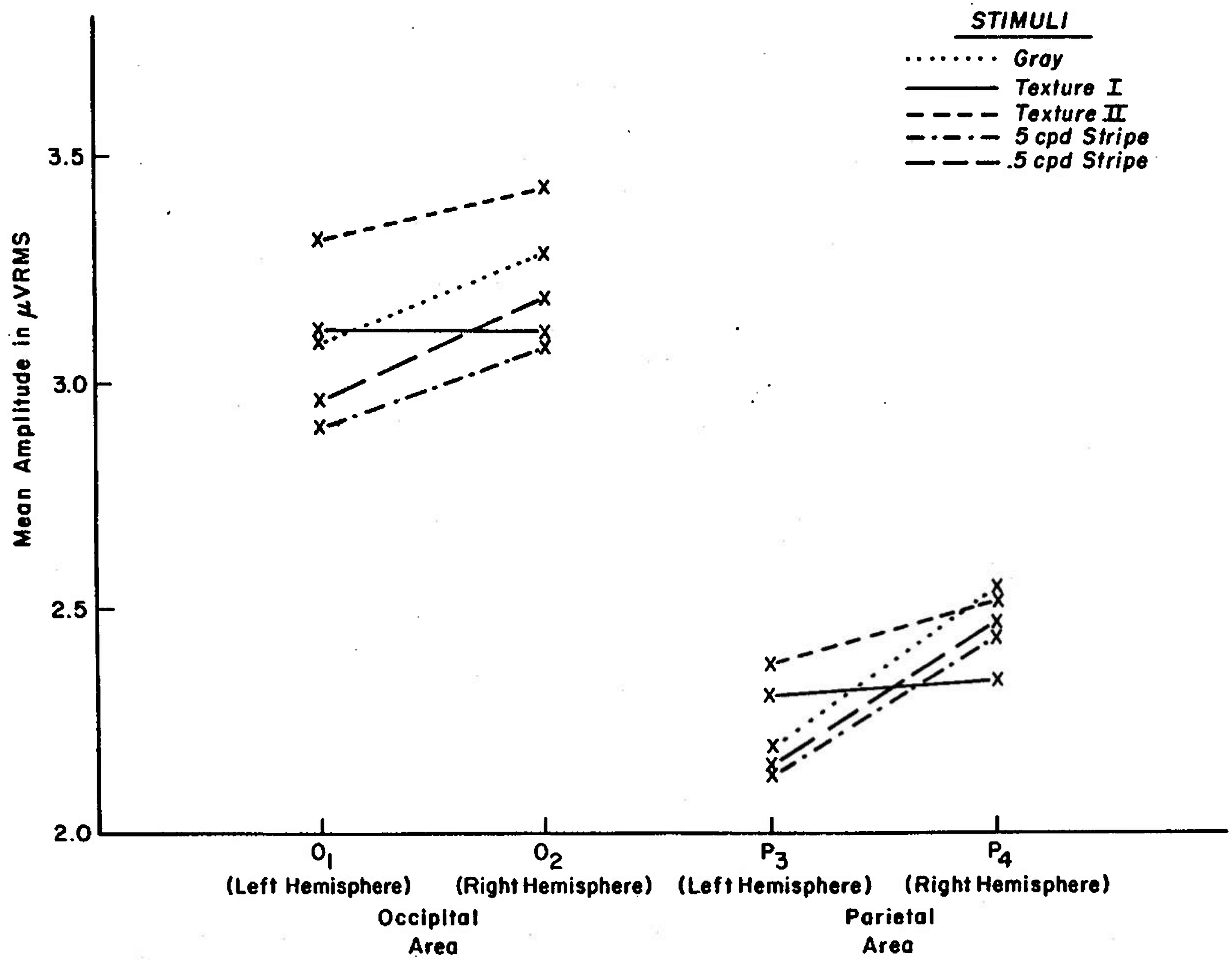

Fig. 1. Power in the VEP (in μRMS) for occipital and parietal areas. Measures for each side of the brain are shown.

There is no obvious reason why this texture pattern would yield a symmetrical response. The difference may be related to the nature of the visual pattern, but the other similiar texture stimulus showed the typical asymmetry. An alternative explanation is based on the fact that all subjects employed in this study had previous experience with texture patterns in other research using a test of texture perception. In this test there is a different texture in one quadrant of each stimulus presented. The subject's task is to determine which quadrant is different. It may be that the subjects were attempting to determine the different quadrant in the patterns and that the success or failure of this processing somehow influenced the amplitude asymmetry. This hypothesis is currently being tested in naive subjects.

Although the overall power of the evoked responses recorded from the parietal area were smaller than that from the occipital area, the amount of asymmetry between sides at the two brain sites was not different. This suggests that either there are no differences between the two sites in the asymmetrical processing of visual patterns or that the μRMS measure is not sensitive enough to find them.

ACKNOWLEDGMENT

We thank Dr. Thomas Santoro for the development of the computer software used to collect and average the visual evoked responses.

REFERENCES

Begleiter, H. (Ed.) Evoked brain potentials and behavior. Plenum Press, New York, 1979.

Callaway, E. Brain electrical potentials and individual psychological differences. Grune & Stratton, New York,1975

Callaway, E., Jones, R. T. and Layne, R. S. Evoked responses and segmental set of schizophrenia. Arch. Gen. Psychiatry 12: 83-89, 1965.

Conners, C. K. Cortical visual evoked responses in children with learning disorders. Psychophysiology 7: 418-428, 1970.

Inderbitzen, L. B., Buchsbaum, M., Silverman, J. EEG-averaged evoked response and perceptual variability in schizophrenics. Arch. Gen. Psychiatry 23: 438-444, 1970.

Kimuri, D. Cerebral dominance and the perception of verbal stimuli. Can. J. Psychol. 15: 166-171, 1961.

Kimuri, D. Functional asymmetry of the brain in dichotic listening. Cortex 3, 163-178, 1967.

Lewis, G. W. and Rimland, B. Psychobiological measures as predictors of sonar operator performance. Navy Personnel Research & Development Center, San Diego, CA, TR80-26, 1980.

Lewis, G. W., Rimland, B. and Callaway, E. Psychobiological predictors of success in a Navy remedial reading program. Navy Personnel Research & Development Center, San Diego, CA, TR77-13, 1976.

Lewis, G. W., Rimland, B. and Callaway, E. 1979, personal communication.

Malerstein, A. J., Callaway, E. Two-tone average evoked response in Korsakoff patients. J. Psychiatr. Res. 6: 253-260, 1969.

Marsh, G. R. Asymmetry of electrophysiological phenomena and its relation to behavior in humans. In M. Kinsbourne (Ed.) Asymmetrical function of the brain. Cambridge Univ. Press, Cambridge,1978, pp 292-317.

Preston, M. S., Guthrie, J. T. and Childs, B. Visual evoked responses (VERs) in normal and disabled readers. Psychophysiology 11: 452-457, 1974.

Rhodes, L. E., Dustman, R. E. and Beck, E. C. The visual evoked response: A comparison of bright and dull children. Electroencephalogr. Clin. Neurophysiol. 27: 364-372, 1969.

Richlin, M., Weisinger, M., Weinstein, S., et al. Interhemispheric asymmetries of evoked cortical responses in retarded and normal children. Cortex 7: 98-105, 1971.

Rugg, M. D. and Beaumont, J. G. Late positive component correlates of verbal and visuospatial processing. Biol. Psychol. 9: 1-11, 1979.

Santoro, T. and Fender, D. Rules for the perception of connectivity in random dot patterns. Vision Res. 16: 973-981, 1976.

Springer, S. P. Tachistoscopic and dichotic-listening investigations of laterality in normal human subjects. In S. Harnad, R. W. Doty, L. Goldstein, J. Jaynes and G. Krauthamer, (Eds.) Lateralization in the nervous system. Academic Press, New York, 1977,pp 325-336.

Sobotka, K. R. and May, J. G. Visual evoked potentials and reaction time in normal and dyslexic children. Psychophysiology 14: 18-24, 1977.

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER NSMRL Report Number 934	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) INTERHEMISPHERIC ASYMMETRIES IN VISUAL EVOKED POTENTIAL AMPLITUDE		5. TYPE OF REPORT & PERIOD COVERED Interim report
		6. PERFORMING ORG. REPORT NUMBER NSMRL Report No. 934
7. AUTHOR(s) C. L. SCHLICHTING, DAVID F. NERI and SCOTT W. KINDNESS, HM3, USN		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS Naval Submarine Medical Research Laboratory Box 900, Naval Submarine Base Groton, Connecticut 06340		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS 61153N MR041.01.03-0155
11. CONTROLLING OFFICE NAME AND ADDRESS Naval Submarine Medical Research Laboratory Box 900, Naval Submarine Base Groton, Connecticut 06340		12. REPORT DATE 12 Jun 1980
		13. NUMBER OF PAGES 8
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office) Naval Medical Research and Development Command National Naval Medical Center Bethesda, Maryland 20014		15. SECURITY CLASS. (of this report) Unclassified
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

visual evoked potentials; cerebral dominance; interhemispheric asymmetry

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Interhemispheric differences in visual evoked potential amplitude (microvolts root mean square) were measured in five right-handed male subjects. Five different stimuli were used, and each subject participated in 3 similar test sessions. The stimuli included one gray, two vertical grids, and two random-dot textures. The results showed that interhemispheric asymmetries in amplitude are generally consistent for a given subject, and most subjects show greater amplitude in the right side of the brain. There were no

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

S/N 0102-014-6601 |

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

#20. differences among four of the stimuli in the degree of asymmetry elicited: one stimulus showed no asymmetry. Some of these stimuli will be used in a future study to determine if there is a relationship between the degree of hemispheric asymmetry and various performance measures in sonar operators.